

# COLOR IMAGE PROCESSING DEVICE AND COLOR IMAGE PROCESSING METHOD

## BACKGROUND OF THE INVENTION

### Field of the Invention

[0001]

The present invention relates to a color image processing device such as a color scanner, and a color image processing method used in the color image processing device.

### Description of the Related Art

[0002]

Color scanners are provided with line image sensors which are respectively formed from a charge coupled device (CCD) for each of the colors, red (R), green (G), and blue (B), wherein the line image sensors are provided in parallel to one another and displaced slightly from one another in a sub scanning direction. In this type of color scanner, since the line image sensors for each of the colors are provided in parallel to one another, the line image sensors cannot physically scan each of the colors on the same line of an original document at the same time. Therefore, a conventional color scanner includes a line memory which delays image data, and by maintaining a delay amount according to a rate of magnification, the color scanner extracts image data from the line memory, and arranges the image data of R, G, B scanned from a line on the same original document. However, according to the rate of magnification, there are cases when the color scanner cannot support image data just by the delay amount of the line. Therefore, there is a technology being proposed to change the time for starting a main scanning operation in accordance with the

rate of magnification.

[0003]

As described above, if the delay amount of the line is changed, and the time for starting the main scanning operation is also changed, the color scanner can support various rates of magnification. However, there is a problem that the circuitry for an image processing device becomes extremely complicated.

## SUMMARY OF THE INVENTION

[0004]

An advantage of the present invention is to provide a color image processing device which can enlarge or reduce an image under an arbitrary rate of magnification at a low cost, without enlarging the size of the circuitry.

[0005]

According to a first aspect of the present invention, a color image processing device includes  $n$  line sensors (line image sensors) arranged with a prescribed interval  $L$  between one another, an image data output unit which outputs image data from the line sensors under a prescribed cycle, and a line memory which stores image data for a plurality of lines and outputs the image data with a delay.

[0006]

According to a second aspect of the present invention, when  $P$  is an interval between pixels in a sub scanning direction during a scanning operation using 100% magnification, the number of pixels which increases and decreases by the rate of magnification is calculated by  $N \cdot L/P$ . Then, it is determined which cycle is to be selected in accordance with a decimal part  $d$  of the calculated number, and a number of delayed lines is determined in accordance with an integral part  $D$ . A determination for selecting a cycle and the number of delayed lines can be made by a simple calculation.

[0007]

According to a third aspect of the present invention, the color image processing device further includes a table of the decimal part d and the selected cycle. Therefore, a determination for selecting a cycle can be made easily in accordance with the calculation and by referring to the table.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0008]

Figure 1 is a block diagram showing a configuration of a color image scanning device according to an embodiment of the present invention.

[0009]

Figure 2 is a time chart showing scanning timing signals of the color image scanning device of the embodiment.

[0010]

Figure 3 is a schematic diagram showing line corrections and sub scanning position corrections of 1 Gap and a line image sensor in the color image scanning device of the embodiment.

[0011]

Figure 4 is a schematic diagram showing a selection of a timing SH in the color image scanning device of the embodiment.

[0012]

Figure 5 is a time chart showing a line delay and a scanning timing when a rate of magnification is 50%, 100% in the color image scanning device of the embodiment.

[0013]

Figure 6 is a time chart showing a line delay and a scanning timing when a rate of magnification is 125%, 200% in the color image scanning device of the embodiment.

[0014]

Figure 7 is a graph showing a relationship between an elapse of time and a position of the line image sensor of when the rate of magnification is 50% in the color image scanning device.

[0015]

Figure 8 is a graph showing a relationship between an elapse of time and a position of the line image sensor of when the rate of magnification is 100% in the color image scanning device.

[0016]

Figure 9 is a graph showing a relationship between an elapse of time and a position of the line image sensor of when the rate of magnification is 125% in the color image scanning device.

[0017]

Figure 10 is a graph showing a relationship between an elapse of time and a position of the line image sensor of when the rate of magnification is 200% in the color image scanning device.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018]

Embodiments of the present invention will be described in detail with reference to the accompanying drawings. Figure 1 is a block diagram showing relevant parts of a color image scanning device which is an embodiment of the present invention. The color image scanning device includes a B signal processing unit 1B, a G signal processing unit 1G, an R signal processing unit 1R, and a control unit 7.

[0019]

The B signal processing unit 1B includes a line image sensor 2B, an Analog Front End (AFE) circuit 3B, a shading correction circuit 4B, a shading

Random Access Memory (RAM) 5B, and a line memory 6B. The G signal processing unit 1G includes a line image sensor 2G, an AFE circuit 3G, a shading correction circuit 4G, a shading RAM 5G, and a line memory 6G. The R signal processing unit 1R also includes a circuit like the B signal processing unit 1B and the G signal processing unit 1G. That is, the R signal processing unit 1R includes an AFE circuit 3R, a shading correction circuit 4R, a shading RAM 5R, and a line memory 6R.

[0020]

The line image sensor 2B separates and reads B signal from an image of one scanning line of a color original document each time a timing signal TS shown in Figure 2 is applied. The line image sensor 2B is driven for each of three timings, SH 1, SH 2, SH 3, which are divided from a cycle of the scanning timing signal TS shown in Figure 2. Then, the line image sensor 2B outputs image data of a scanned one line. The AFE circuit 3B amplifies an analog image signal which is output from the line image sensor 2B. Moreover, the AFE circuit 3B includes an analog to digital converter (not shown in the drawings). The AFE circuit 3B converts the analog image signal into digital data, and outputs the converted digital data as multi-value digital image data. Further, in the present embodiment, the cycle of the timing signal is divided into three timings. However, the present invention is not limit to this example, and the cycle can be divided differently.

[0021]

For performing shading corrections, the shading RAM 5B stores an output of the AFE circuit 3B when the line image sensor 2B scans a white reference and a black reference. In the shading correction circuit 4B, the output of the AFE circuit 3B at a scanning operation of an original document is corrected by shading corrected data by the data for shading correction stored in the shading RAM 5B. Then, the shading correction circuit 4B outputs the

shading corrected data. The data output from the shading correction circuit 4B is stored into the line memory 6B by a write enable signal WE transmitted from the control unit 7. Then, the stored data is output sequentially.

[0022]

The write enable signal WE is input to the line memory 6B during any one of the timings SH1, SH2, SH3 divided from the cycle of the scanning timing signal TS shown in Figure 2. The control unit 7 determines a timing to be selected from the timings SH1, SH2, SH3 in accordance with a value calculated based on the rate of magnification.

[0023]

Figure 4 shows a state in which the line image sensor 2B is a standard, and the timing of the selection progresses from SH1 to SH2, SH3, SH1'.

[0024]

The line image sensor 2G separates and reads G signal from the image of one scanning line of a color original document each time the timing signal TS is applied. The line image sensor 2R separates and reads the R signal from the image of one scanning line of a color original document each time the timing signal TS is applied. The line image sensors 2G, 2R are also driven for a timing selected from the timings SH1, SH2, SH3, and the line image sensor 2G, 2R output an image signal of the scanned line. The AFE circuits 3G, 3R, the shading correction circuits 4G, 4R, the shading RAM 5G, 5R and the line memories 6G, 6R are respectively the same circuit as the AFE circuit 3B, the shading correction circuit 4B, the shading RAM 5B, and the line memory 6B. The timing under which the line memories 6G, 6R output the write enable signal WE is determined by the control unit 7 in accordance with each rate of magnification.

[0025]

The line memories 6B, 6G, 6R output data under a timing considering a

delay amount for a correcting gap of the line image sensors 2B, 2G, 2R, and an amount the position in a sub scanning line direction is corrected by the rate of magnification.

[0026]

The line correction and the position correction on the sub scanning line for the line image sensors 2B, 2G, 2R in the color image scanning device of the present embodiment will be described with reference to Figure 3.

[0027]

To carry out the line correction and the position correction on the sub scanning line, first, a number of pixels  $N \cdot m$  which increases and decreases by the rate of magnification is calculated.

[0028]

N: rate of magnification ( $=1/\text{transferred distance at enlargement or reduction}$ )

$m: =L/P$

L: distance between the line image sensors R-B (number of gap lines between the line image sensors R-B)

P: pixel pitch in the sub scanning direction at equal magnification (1 line)

T: interval of pixels scanned

[0029]

When calculating  $N \cdot m = D \cdot d$ , a number of delayed line can be determined from an integral part D, and the timings SH1, SH2, SH3, SH1' can be determined from a decimal part d.

[0030]

SH1 is the timing to write data scanned by the line image sensor 2B into the line memory 6B. With SH1 as the standard, the timing (SH) is determined. Further, the timing (SH) is the timing to write into the line memories 6G, 6R,

the data scanned by the line image sensors 2G, 2R which corresponds to a position the same as a position of an original document scanned by the line image sensor 2B.

[0031]

The timing SH is determined under the following conditions by the decimal part d of the result  $D \cdot d$  calculated from  $N \cdot m$ .

[0032]

SH1:  $0 \leq d < 1/6$

SH2:  $1/6 \leq d < 3/6$

SH3:  $3/6 \leq d < 5/6$

SH1':  $5/6 \leq d < 1$

[0033]

A look up table for calculating  $N \cdot m$ , and a look up table for determining the timing SH from the decimal part d are provided in the control unit 7. The control unit 7 calculates " $N \cdot m = D \cdot d$ ", and a number of delayed lines according to the rate of magnification of the line image scanner, and the correction in the sub scanning direction (optimum timing SH) are selected to realize each correction.

[0034]

For example, in Figure 3, when the number of lines between the line image sensors R-B is 4, and the number of lines between the line image sensors G-B is 2, and the rate of magnification is 100%, between the line image sensors R-B, the number of pixels equals  $N \cdot m = 1.00 \cdot 4/1 = 4.0$ , and  $(R-B)D(\text{integral part}) = 4$ ,  $d(\text{decimal part}) = 0$ .

[0035]

Moreover, between the line image sensors G-B, it becomes  $N \cdot m = 1.00 \cdot 2/1 = 2.0$ , and  $(G-B)D(\text{integral part}) = 2$ ,  $d(\text{decimal part}) = 0$ .

[0036]

In this case, since it is 100% magnification, as shown in Figure 5, in



relation to the line image sensor 2B, the data scanned by the line image sensor 2R can be delayed by four lines, and the data scanned by the line image sensor 2G can be delayed by two lines. A correction of the position in the sub scanning direction is not necessary.

[0037]

Next, when the number of lines between the line image sensors is the same, and the rate of magnification is 125%, between the line image sensors R-B, the number of pixels equals  $N \cdot m = 1.25 \cdot 4 / 1 = 5.0$ , and  $(R \cdot B)D(\text{integral part}) = 5$ , and  $d(\text{decimal part}) = 0$ .

[0038]

Moreover, between the line image sensors G-B, the number of pixels equals  $N \cdot m = 1.25 \cdot 2 / 1 = 2.5$ , and  $(G \cdot B)(\text{integral part}) = 2$ , and  $d(\text{decimal part}) = 0.5$ .

[0039]

Therefore, as shown in Figure 6, in relation to the line image sensor 2B, the data scanned by the line image sensor 2R is delayed by five lines, and the data scanned by the line image sensor 2G is delayed by 2.5 lines.

[0040]

Moreover, since the decimal part  $d = 0$ , the timing signal SH1 is selected for the timing to write the data scanned by the line image sensor 2R into the line memory 6R, like in the line image sensor 2B. However, since the decimal part  $d = 0.5$ , the timing signal SH3 is selected for the timing to write the data scanned by the line image sensor 2G into the line memory 6G from the above conditional expression.

[0041]

Moreover, when the number of lines between the line image sensors R-B is 4, and the number of line between the line image sensors G-B is 2, and the rate of magnification is 200%, between the line image sensors R-B, the number of pixels equals  $N \cdot m = 2.0 \cdot 4 / 1 = 8.0$ , and  $(R \cdot B)D(\text{integral part}) = 8$ , and  $d(\text{decimal$

part)=0. Moreover, between the line image sensors G·B, the number of pixels equals  $N \cdot m = 2.0 \cdot 2 / 1 = 4.0$ , and  $(G \cdot B)D(\text{integral part}) = 4$ , and  $d(\text{decimal part}) = 0$ .  
[0042]

Therefore, as shown in Figure 6, in relation to the line image sensor 2B, the data scanned by the line image sensor 2R is delayed by eight lines, and the data scanned by the line image sensor 2G is delayed by four lines. Moreover, since the decimal part  $d=0$  between the line image sensors R·B, and between the line image sensors G·B, the position in the sub scanning direction is not necessary to be corrected. In this case, the timing SH1 is selected for the G signal and the R signal.

[0043]

Furthermore, when the number of lines between the line image sensors is the same, and the rate of magnification is 50%, between the line image sensors R·B, the number of pixels equals  $N \cdot m = 0.5 \cdot 4 / 1 = 2.0$ , and  $(R \cdot B)D(\text{integral part}) = 2$ , and  $d(\text{decimal part}) = 0$ . Moreover, between the line image sensors G·B, the number of pixels equals  $N \cdot m = 0.5 \cdot 2 / 1 = 1.0$ , and  $(G \cdot B)D(\text{integral part}) = 1$ , and  $d(\text{decimal part}) = 0$ .

[0044]

Therefore, as shown in Figure 5, in relation to the line image sensor 2B, the data scanned by the line image sensor 2R is delayed by two lines, and the data scanned by the line image sensor 2G is delayed by one line. Moreover, since the decimal part  $d=0$  between the line image sensors R·B and between the line image sensors G·B, the position in the sub scanning direction is not necessary to be corrected. In this case, the timing SH1 is also selected for the G signal and the R signal.

[0045]

Figure 7 through Figure 10 show a relationship between an elapse of time and the positions of each of the line image sensors of when the gap between

the line image sensors R-B is four lines, and the gap between the line image sensors G-B is two lines, and the rate of magnification is respectively 50%, 100%, 125%, 200%. Especially when referring to Figure 9 wherein the rate of magnification is 125%, the R signal, the G signal, and the B signal are output in proximity to the same scanning line more in the present invention wherein the correction is made according to the number of lines, and the lines are further divided for a further correction to be made, than the conventional way wherein the correction is made according to only the number of lines.